Ser. 10/085790

(12) UK Patent Application (19) GB (11) 2 083 375 A

(21) Application No 8126363
(22) Date of filing
28 Aug 1981
(30) Priority data
(31) 184756
(32) 8 Sep 1980
(33) United States of America (US)
(43) Application published
24 Mar 1982
(51) INT CL³ B02C 7/11
(52) Domestic classification
B2A 5G 5H 5R10 5R11A 5R1X 5R4 5R5 5R6
(56) Documents cited
None
(58) Field of search
B2A
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(54) Disc mills

(57) Pulp stock, such as wood chips, sawdust, bagasse and the like is refined in a disc mill having a pair of axially-adjustable relatively rotable discs in a closed housing. The grinding space 34 between the discs comprises an inner grinding zone which extends in a plane substantially perpendicular to the axis of rotation of the discs and an outer grinding zone which merges with and extends at an angle to the plane of the inner grinding zone. The outer inclined grinding zone is defined between a rotating disc member 12 and a correspondingly inclined grinding surface of a stationary element of the other disc member and is adjustable to vary the width of the outer grinding zone. The angled portion of the rotating disc member is provided with exhaust passages or channels 76 for evacuating steam from the pulp stock as it is being ground in the inclined outer grinding zone. The steam and stock may be separated by dividing the grinding chamber with a seal ring 82.

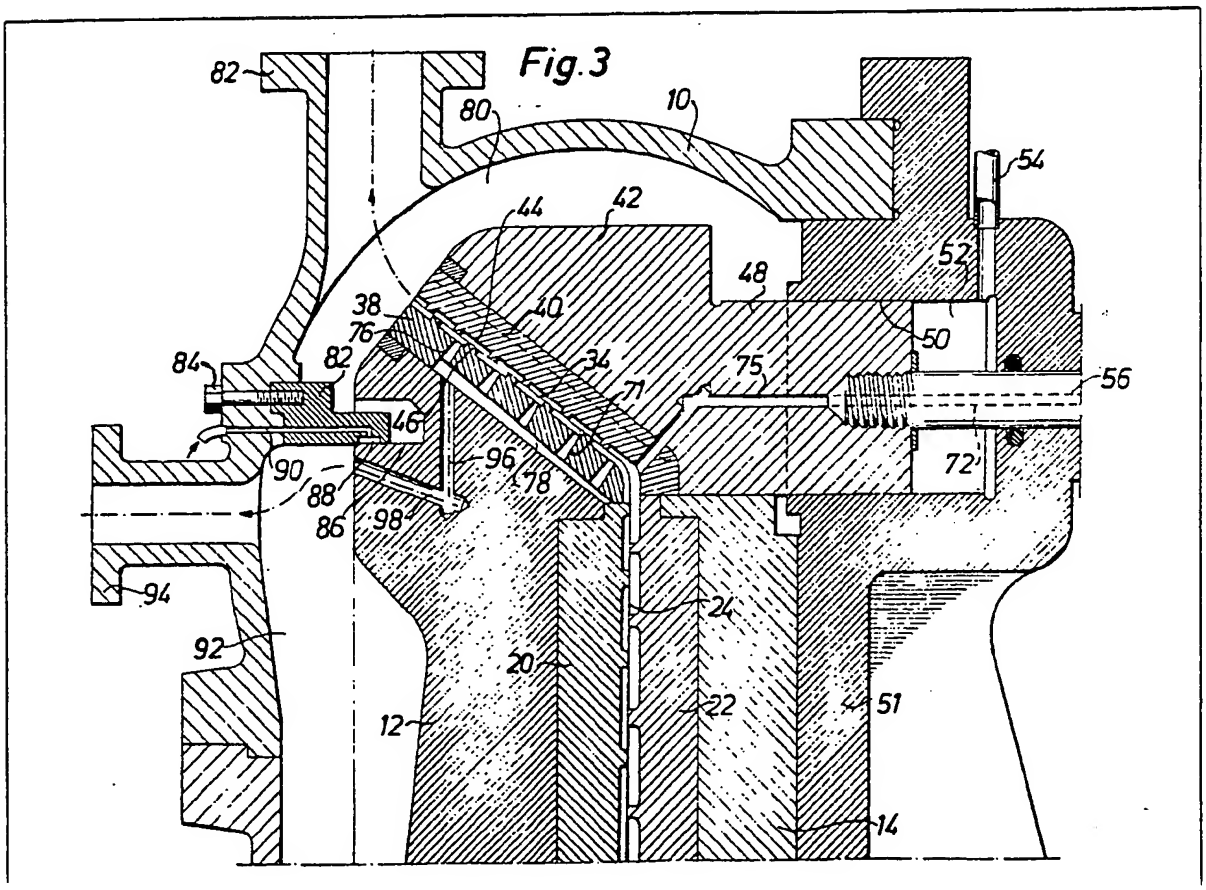

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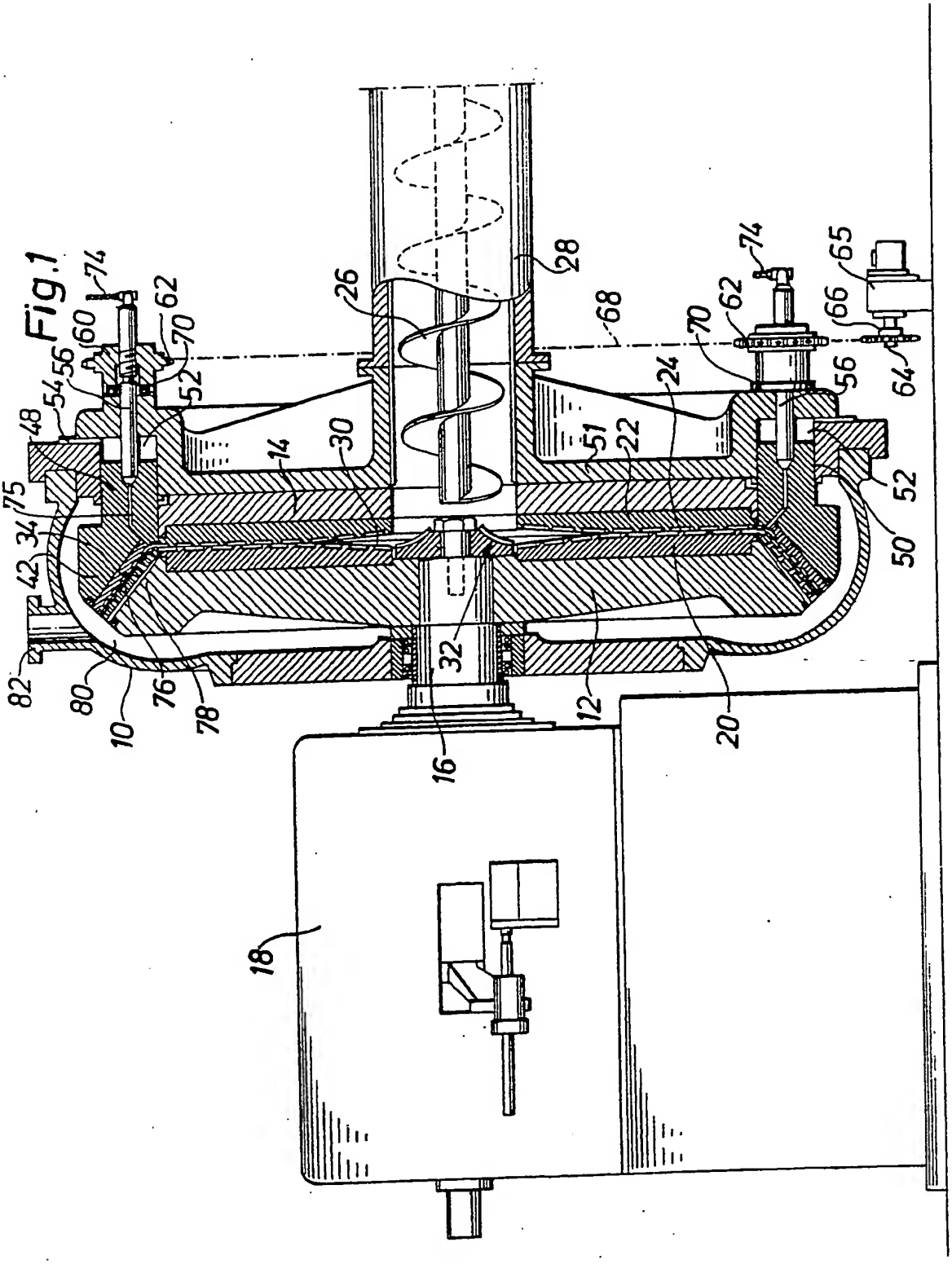
Fig.1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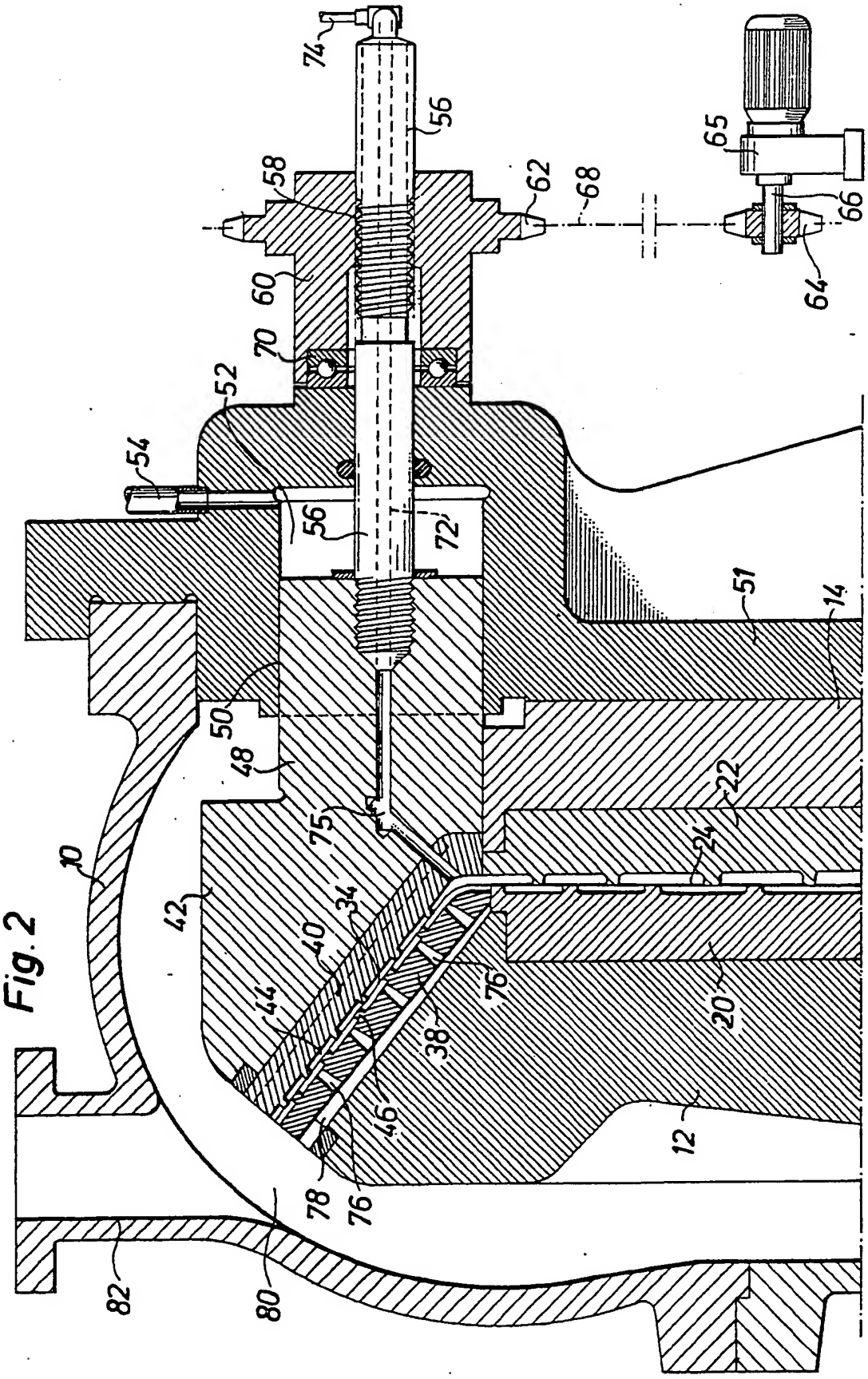
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Fig. 2

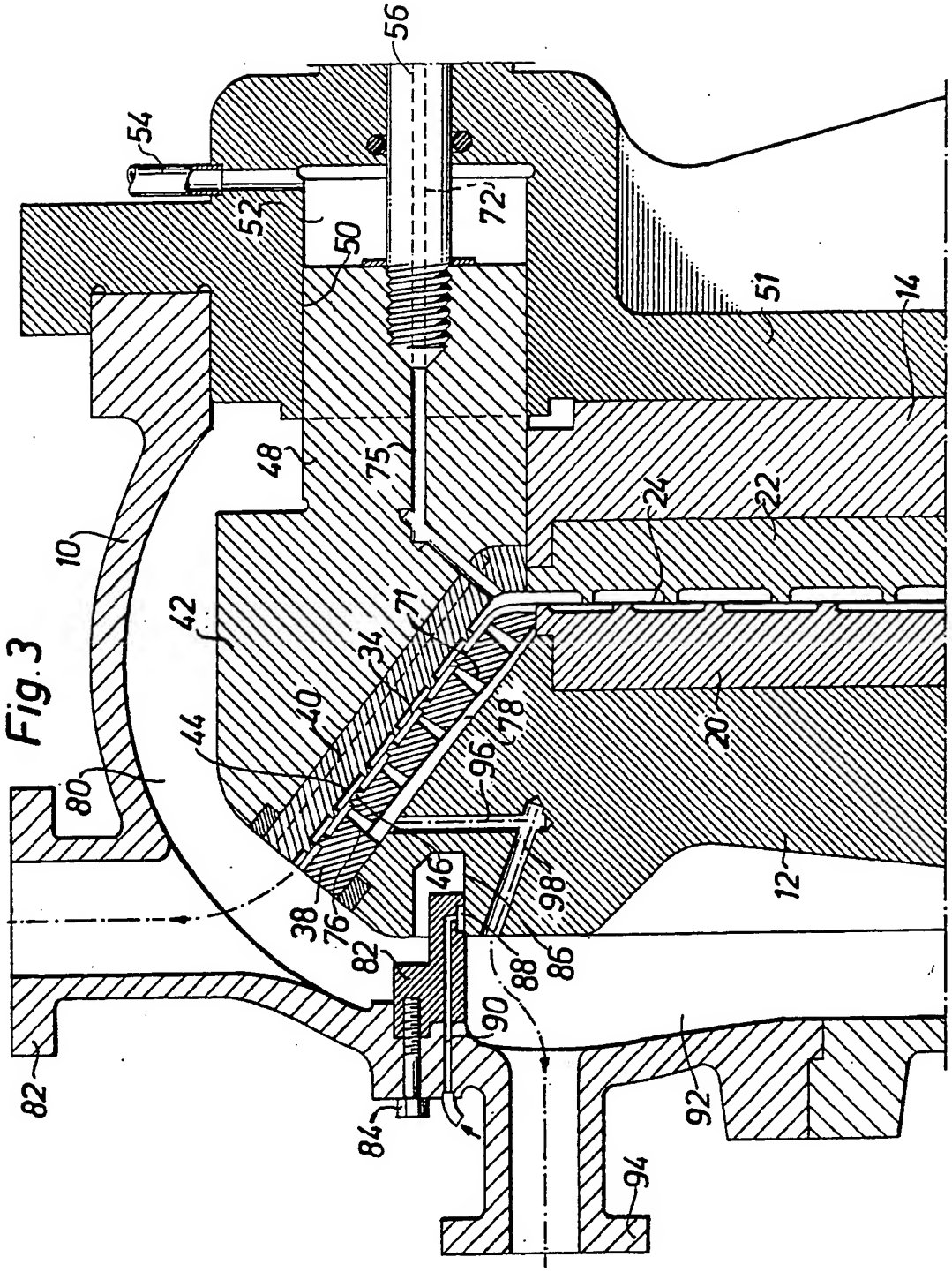
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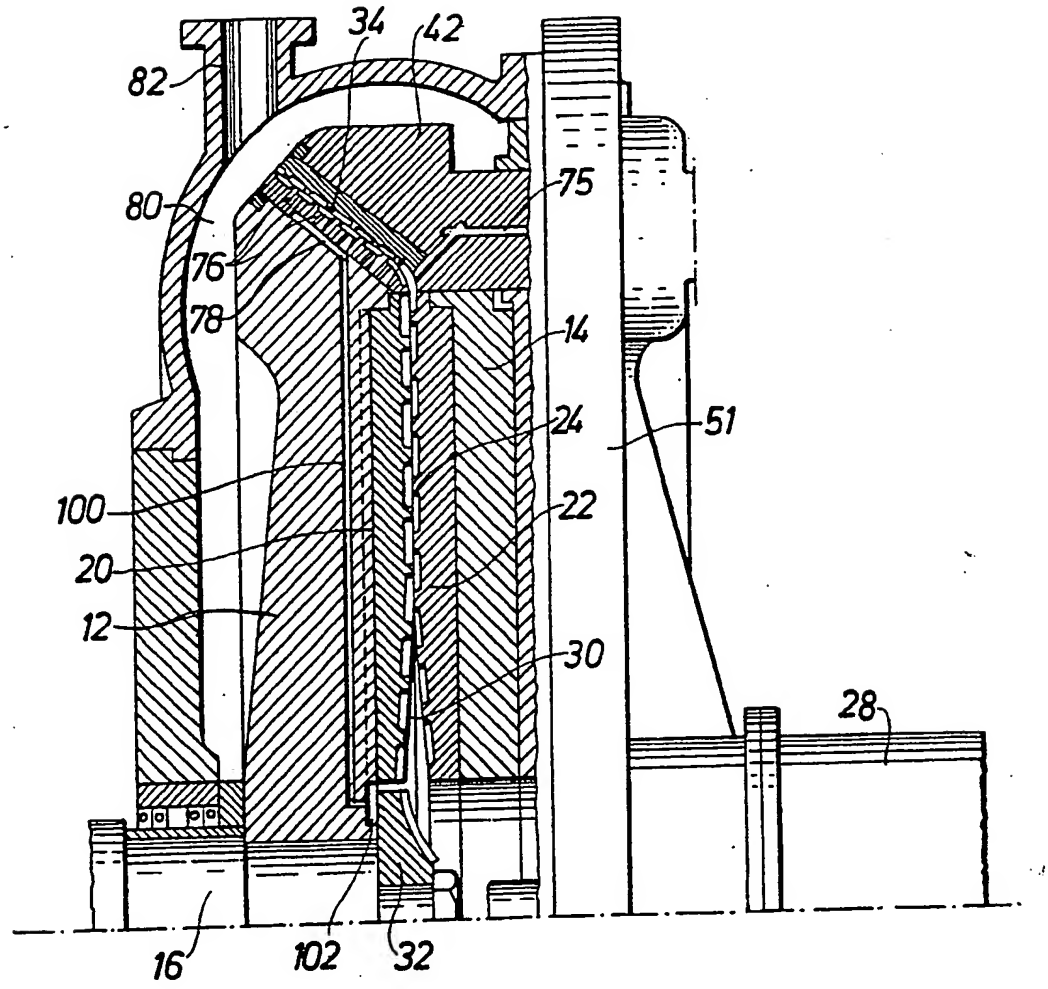
Fig. 3

Fig.4



SPECIFICATION

Method and apparatus for grinding pulp material in a disc-type refiner

The present invention relates to a method and an apparatus for grinding piece-shaped, preferably lignocellulose-containing material. The apparatus is equipped with grinding members housed in a casing and rotatable relative to one another which with opposed surfaces form grinding surfaces for disintegration of the pulp stock into finely divided form. A main field of application are those apparatus which are denominated defibrators or refiners for manufacture of fibre or paper pulp from vegetable material in the shape of wood chips, saw dust,bagasse or the like. Such apparatus have at least two disc-shaped members rotatable relative to one another, which means that these members have cooperating grinding surfaces with extension in radial direction. It is known from e.g. the co-pending U.S. patent application Ser. No. 877,809 filed February 12, 1978, to design these grinding surfaces with a radially inner portion with main extension in radial direction and a radially outer portion with main extension in axial direction, at least the outer portion serving as grinding space and to this purpose being formed with ridges, grooves and notches.

One of the co-operating grinding members may be stationary in its entirety or, as has been proposed in the co-pending U.S. patent application Ser. No. 22,184 filed March 16, 1979, be composed of two elements of which the outer one is stationary whereas the inner one rotates in opposite direction to the other disc member which is entirely rotatable. By this construction of the defibrator or refiner the grinding space between their disc-shaped members is divided up into an inner portion which has a central inlet opening for the material to be ground and within which the relatively feeble centrifugal force can be utilized maximally for feed of the material into the outer portion which by appropriate coordination of diameter, number of revolutions and grinding pressure can be imparted high productivity and capacity of disintegration combined with relatively low power consumption. These factors at a power supply of e.g. 10,000 KWh or more have also as a result that steam is generated in the grinding space from liquid (water) present in the pulp stock under a steam pressure which is sufficiently high to overcome the resistance in the stock under the grinding treatment and to find its way out of the space between the grinding members. The escape of the steam which partly takes place against, and partly along, the direction of the flow of material has a feeding of the stock into the steam-generating grinding zone and shortens the period of stay of the stock in the outer grinding zone.

One main object of the invention is to improve the efficiency and capacity of a grinding apparatus of the aforesaid type by eliminating the unfavourable influence of the generated steam on the flow of the stock within the grinding zone. This is obtained substantially according to one main feature of the invention thereby that the steam present in the grinding space is separated from the pulp stock against the effect of the centrifugal force through inwards directed channels formed in the rotatable grinding member constituting the radially inner grinding surface prior to the discharge of the stock from the grinding space at the outer periphery of said space. An apparatus especially suited for carrying out the method of the invention is substantially characterized by the feature that the rotatable disc member forming the radially inner grinding surface of the outer grinding space portion is provided with inwards extending exhaust channels for separating steam from the pulp stock against the effect of the centrifugal force prior to the discharge of the same from, or admission into, said outer grinding space portion.

Due to the fact that the exhaust passages for the steam start from the rotatable inner grinding surface which borders the axially inclined grinding space portion, a separation of the steam from the pulp stock is effected, said stock thus by the action of the high centrifugal force being retained in the grinding space and while being disintegrated into fibres and/or fibrilles conveyed towards the outer periphery of said space. The retarding effect which according to the above-cited copending patent applications is exercised on the material by splitting the effect of centrifugal force into a vector acting at right angles to the grinding surface and which exceeds the vector of said force acting in the direction of flow of the material results in that the dwelling time of the material in the grinding zone and therethrough the grinding effect attain most favourable values.

Further objects, characterizing features and advantages of the invention will become apparent from the following description, considered in connection with the accompanying drawings which form part of this specification and of which:—

Figure 1 is a vertical longitudinal section of a grinding apparatus constructed in accordance with the present invention,

Figure 2 is a partial view on an enlarged scale of the apparatus shown in Fig. 1,

Figures 3 and 4 are longitudinal sections of the grinding apparatus according to two alternative embodiments.

Referring now to the drawings and in parti-

casing or housing in which are mounted a rotating grinding member or disc and rotationally stationary grinding member generally indicated by the reference numerals 12 and 14, respectively. The rotating grinding disc is mounted on a shaft 16, which in conventional manner is journalled in a portion 18 of the frame of the apparatus. The two grinding members are in known manner lined on their opposing faces with rings or segments 20 and 22, respectively, which suitably are subdivided into a plurality of concentrical part-circular bodies and which between themselves define a grinding space 24 which extends in a plane perpendicular to the axis of rotation of the shaft 18 and which forms an inner or primary grinding zone. The material to be ground, e.g. in the shape of preheated wood chips, is supplied by a feed screw 26 housed in a central inlet socket 28 which in turn is connected to the casing 10. The material is conveyed by the screw to a feed-out zone 30 at the radially inner side of the grinding space and therefrom in outward direction between the grinding segments 20 and 22. Mounted on the disc 12 is also a deflector member 32 by which the material to be ground supplied by the screw 26 is pushed towards the feed-out zone 30.

The portion 18 of the apparatus frame may in addition to the journals and bearings for the shaft 16 and means for rotation of said shaft contain servo motor members which permit axial displacement of the disc 12 and at the same time produce the axially acting grinding pressure between the two grinding members. This servo motor may further be designed so as to permit adjustment of the width of the grinding space 24 to, and maintenance thereof at, a desired predetermined value. The frame portion 18 with the members associated therewith are known from e.g. the U.S. Patent 3,212,721, and shall not be described here in detail. especially as it forms no part of the present invention.

Axially outside the radial grinding space 24 is formed a grinding space 34, which in the embodiment illustrated in the drawings has extension in axial direction and a frustro-conical profile. According to the disclosure in the aforecited US patent application Ser. No. 877,809, this grinding space 34 extends at an angle to the plane of the inner grinding space 24, which plane is perpendicular to the axis of rotation of the rotatable grinding member 12. Said angle is greater than 45°, as is diagrammatically indicated in the drawings. Preferably, said angle should exceed 60–70°. Especially good results have been achieved with angles ranging between 75° and 82°.

As is best seen from Figs. 2 and 3, the radially inner grinding surface of the space 34 is formed by grinding segments 38 which are rigidly secured onto the rotatable disc 12. The is formed by segments 40 which are carried by an annular element 42 which is concentrical with the shaft 16. The segments 40 thus have an interior or concave space surface 44 surrounding the exterior space surface 46 of the rotatable segments 38. The rotationally stationary annular element 42 is axially displaceable for adjustment of the width of the grinding space 34 between the two space surfaces 44, 46 independent of the spacing between the grinding members 12 and 14 which is determined by the width of the gap 24. For the said axial displacement the annular element 42 is centered on the rotationally stationary grinding member 14 and provided with an annular piston 48, which with sliding fit is axially displaceable within a cylindrical ring chamber 50 formed in either the stationary casing 10 or a cap 51 associated therewith. Into an inner space 52 of the chamber 50 a medium under pressure, such as , for example, steam, air, water oil or the like, is fed through a pipe 54. This pressure is sufficiently high to overcome the force component acting in the opposite direction of the griniding pressure exercised on the stock and also the pressure from the steam generated between the surfaces defining the grinding space. The movement of the stator element 42 and the annular piston 48 in the direction towards the rotating grinding member 12 is controlled and limited by a number of bolts 56 evenly distributed about the circumference of the piston and rigidly fixed in said piston and by threads 58 formed at their outer ends in engagement with setting knobs 60 which are actuated by a common transmission comprising a sprocket 62 on each of the knobs, a driving wheel 64 mounted on the shaft 66 of an adjusting motor 65 and a transmission chain 68 running over all sprockets. Positioned between the setting knobs and casing 10 are bearings 70. The bolts 56 may each have an inner channel 72 extending from end to end and at their one end communicating with a supply pipe 74 for a cooling liquid under pressure, such as water, and at their other end with channels 75 opening into the grinding space, most suitably at the transition of the two zones thereof, viz.24 and 34, respectively. In this way liquid supplied to the outer grinding zone 34 to cool the stock and constitute the replacement for the steam generated there so as to prevent the stock from becoming overheated.

In the inner radial grinding zone 24 the pulp stock coming from the feed-out zone 30 will to full extent be acted upon by the centrifugal force. In this inner grinding zone the stock is subjected to an initial disintegration. When the stock thereupon passes over into the outer grinding zone 34 the action of the centrifugal force grows to very high values, but its effect on the propulsion of the

Hereby, a compensation is obtained for the power of the centrifugal force otherwise increasing with increase of the radius. As a result the flow velocity of the pulp stock is reduced in the direction of flow and therewith the period of treatment in the apparatus prolongated. The centrifugal force acting on the pulp stock has a component perpendicular to the generatrices of the space 34 and absorbed by the stationary angular element 42, whereas the component acting in the direction of flow of the pulp constitutes a minor portion only of the total centrifugal force.

The grinding segments 22, 20 and 38, 40 are on their opposing surfaces in known manner formed with ridges separated from one another by grooves with extension in the direction of the flow of the material, and also with transversely extending projections subdividing the grooves into smaller sections.

In the operation of the grinding apparatus, the material to be ground such as the wood chips, is subjected especially in the outer inclined grinding space 34 to an intensive disintegration treatment resulting in separation of the fibres from one another and/or uncovering of the fibrilles by the high grinding pressure applied from outside and the high peripheral speed which is a consequence of the increase of diameter in the outer grinding zone. The supply of much energy results in that steam is generated under high pressure which acts on the flow of pulp stock and thereby counteracts the retarding effect which the axial extension of the grinding zone has on the pulp stock flow. In accordance with the leading idea of the present invention, there are formed in the grinding segments 38 of the rotatable grinding disc 12 grooves or channels 76 which extend radially inwards from the grinding space 34. Preferably, a plurality of such channels are distributed over the grinding space in the direction of flow, the various channels having a common collecting channel 78 for exhaust of the steam. Channels 76 with collecting channel 78 may be provided at several places about the circumference of the rotating grinding disc 12. The steam generated in the grinding space will now against the direction of the centrifugal force stream inwards in the channels 76 to become separated from the pulp stock which due to the high value of the centrifugal force will stay much longer than otherwise in the grinding space and while being ground continuously be moved slowly towards, and finally discharged from the outer periphery thereof. The finally ground fibres are whirled into a chamber 80 of the grinding casing 10 within which over-pressure prevails, and sluiced out through an outlet 82.

In the embodiment illustrated in the Figs. 1 and 2 the collecting channel or channels 78 the fibre pulp stream.

In the embodiment according to Fig. 3, the casing 10 enclosing the grinding members is subdivided into two chambers by means of a sealing ring 82 which is fixed in the casing 10 by screw members 84 and therefrom projects into an annular recess 86 in the rotatable disc 12 and forms sealing surfaces 88 with said recess. To these surfaces a fluid, such as water, can be supplied through a bore 90. This fluid is under higher pressure than the pressure prevailing in both chambers of the casing. In this way, the casing is divided into a chamber 80 from which the finally ground pulp stock is discharged and a chamber 92 with outlet 94 into which the steam is exhaused from the collecting channel 78 through channels 96, 98 formed in the disc 12. Uncompletely treated pulp stock which follows with the separated steam can now easily be picked up and returned to the grinding space.

A generation of steam takes place also in the inner radial grinding zone 24, although to a minor extent than in the outer grinding zone 34. This steam partly flows against the direction of flow of the stock and then can be utilized for preheating the stock, or for other purposes, and partly follows the flow of material to the outer grinding zone.

The embodiment according to Fig. 4 differs from the preceding ones by the steam separated out in the outer grinding space 34 being carried away through the collecting channel 78 and return channels 100 to the feed-in zone 30 and therefrom to the radial grinding space 24. The rotating disc member 12 has suitably a plurality of channels distributed about the circumference, which channels open near to the centre into a space 102 adjacent the deflector member 30.

The major part of the steam generated during the grinding process and by the action of the centrifugal force more or less completely made from pulp stock is by the described channel system returned to the feed-in opening of the apparatus where it can be utilized for preheating of the material to be ground or be discharged to be used for other purposes without this steam streaming in opposite direction to the flow of the pulp stock disturbing the advance of the stock towards the steam-generating zone.

By direction the steam to the intake side of the grinding space between the disc members pulp stock particles possibly not yet finally ground will automatically be returned to the grinding zones for renewed treatment.

CLAIMS

1. A method of removing steam from the grinding space between two grinding members rotatable relative to one another in a grinding apparatus for pipes-shaped, prefera-

grinding space at least in a radially outer portion having mainly axial extension from a central inlet towards a peripheral outlet for the pulp stock passing the periphery of the grinding members, characterized in that the steam is separated from the stock against the action of the centrifugal force through inwards directed channels formed in the rotatable grinding member constituting the radially inner grinding surface prior to the discharge of the stock from the grinding space at the outer periphery of said space.

2. A method according to claim 1, characterized in that the steam separated from the pulp stock in the space is reunited with the pulp stock leaving the grinding space.

3. A method according to claim 1, characterized in that the separated steam is deducted from the grinding casing in a flow separate from the flow of pulp stock.

4. A method according to claim 1, characterized in that the separated steam at least partly is returned to the intake side for the pulp stock material ahead of the grinding space.

5. A grinding apparatus for piece-shaped, preferably lignocellulose-containing material, of the dis-type, the opposing surfaces of the relative to each other rotatable disc members of which housed in a casing comprise, calculated from the interior centre of rotation, a portion having the main extension in radial direction and an outer portion having the main extension in axial direction, at least the outer portion forming a grinding space and having grinding surfaces formed with grooves and ridges for disintegration of the material to be ground under such conditions as to cause generation of steam in the space, characterized in that the rotatable disc member forming the radially inner grinding surface of the outer grinding space portion is provided with inwards extending exhaust channels for separating such steam from the pulp stock against the action of the centrifugal force prior to the discharge of the stock from, or admission thereof into, said outer grinding space portion.

6. A grinding apparatus according to claim 5, characterized in that the channels open into the casing so that the separated steam is mixed with pulp stock on discharge from the outer periphery of said grinding space portion.

7. A grinding apparatus according to claim 5, characterized in that the steam separated from the pulp stock in the grinding space is exhausted through channels which are separate from the way for the pulp stock on discharge from the space.

8. A grinding apparatus according to claim 5, characterized in that the casing by sealing members provided between the same and the rotatable disc member is divided into two chambers, the channels opening into one receiving room for the finally ground pulp stock which from there is fed out through an outlet in the casing.

9. A grinding apparatus according to claim 5, characterized in that the channels are directed inwards towards the centre of the disc member for transfer of at least a portion of the separated steam to the inlet side for the pulp stock material ahead of the grinding space.

10 A grinding apparatus according to any of the preceding claims 5 to 9, characterized in that the grinding surface of the rotatable disc member has several outlets for the steam located in spaced relation from one another in the direction of flow of the pulp stock or on different radial spacing from the centre, said outlets being extended to a common collecting channel in the said disc member.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1982.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.